Barriers and facilitators of vigorous cardiorespiratory training in axial Spondyloarthritis: Surveys among patients, physiotherapists, rheumatologists

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Abstract: OBJECTIVE Vigorous cardio-respiratory training (vCRT) in patients with axial Spondyloarthritis (axSpA) is effective, safe and feasible, however not yet adopted in axSpA exercise programmes. We therefore aimed to explore the barriers and facilitators for vCRT among patients, physiotherapists (PTs) and rheumatologists. METHODS "Stakeholder-specific surveys examined perceptions of barriers and facilitators to vCRT organized under categories identified by Grol Wensing. Respondents chose the 3 most important barrier and facilitator categories and rated individual items on a 4-point scale. Frequencies and proportions were calculated; ratings between active and inactive patients were compared." RESULTS Patients (n= 575, response rate 34%): the top-3 barrier categories included 'low motivation' (n=317=/59%),' unsuccessful timing in daily routine' (n=292/55%) and 'hindering disease symptoms' (n=272/51%). The top-3 facilitator categories were 'high motivation' (n=248/47%), 'good organisational conditions' (n=217/41%), 'facilitating disease symptoms' (n=209/40%). More inactive than active patients chose 'low motivation' as barrier (p=0.01). PTs (n= 40, response rate 48%): The top-3 barrier categories included 'heterogeneous group composition' (n=26/70%), 'difficult organisational conditions' (n=19/51%) and 'low motivation' (n=19/51%). The PTs' top-3 facilitator categories were 'knowledge' (n=20/54%), 'homogeneous group composition' and 'high perceived motivation' (both n=17/46%). Rheumatologists (n=73, response rate 17%; with 54 (74%) answering barrier items and 68 (93%) answering facilitator items): Strongest barriers included 'not enough information' (n=25/47%) and 'anticipated /perceived disinterest of patient (n=27/50%). Strongest facilitators included 'exercise important topic even in limited consultation time' (n=65/96%) and 'clear evidence for effectiveness of flexibility exercises' (n=62/91%). CONCLUSION The identified facilitators and barriers will guide the development of stakeholder-specific implementation strategies.

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Abstract

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Methods: "Stakeholder-specific surveys examined perceptions of barriers and facilitators to vCRT organized under categories identified by Grol & Wensing. Respondents chose the 3 most important barrier and facilitator categories and rated individual items on a 4-point scale. Frequencies and proportions were calculated; ratings between active and inactive patients were compared."

Results: Patients (n= 575, response rate 34%): the top-3 barrier categories included 'low motivation' (n=317=/59%),' unsuccessful timing in daily routine' (n=292/55%) and 'hindering disease symptoms' (n=272/51%). The top-3 facilitator categories were 'high motivation' (n=248/47%), 'good organisational conditions' (n=217/41%), 'facilitating disease symptoms' (n=209/40%). More inactive than active patients chose 'low motivation' as barrier (p=0.01). PTs (n= 40, response rate 48%): The top-3 barrier categories included 'heterogeneous group composition' (n=26/70%), 'difficult organisational conditions' (n=19/51%) and 'low motivation' (n=19/51%). The PTs' top-3 facilitator categories were 'knowledge' (n=20/54%), 'homogeneous group composition' and 'high perceived motivation' (both n=17/46%). Rheumatologists

(n=73, response rate 17%; with 54 (74%) answering barrier items and 68 (93%) answering facilitator items): Strongest barriers included ‘not enough information’ (n=25/47%) and ‘anticipated /perceived disinterest of patient (n=27/50%). Strongest facilitators included ‘exercise important topic even in limited consultation time’ (n=65/96%) and ‘clear evidence for effectiveness of flexibility exercises’ (n=62/91%).

Conclusion: The identified facilitators and barriers will guide the development of stakeholder-specific implementation strategies.

Significance and innovations

- This survey identified barriers and facilitators for vigorous cardio-respiratory training (vCRT) among patients with axial spondyloarthritis (axSpA), physiotherapists, and rheumatologists, as basis for systematically implementing vCRT in exercise programs for people with axSpA.
- Generally, items were more often perceived as being facilitators than as barriers; however some facilitators were more important for physically active patients and some barriers were more important for inactive patients, demonstrating the need to tailor exercise programs to individual needs
- While patients and physiotherapists considered motivation-related items to be important facilitators to engage in vCRT, rheumatologists gave more weight to the evidence for including vCRT as part of managing the disease.

Introduction

Axial Spondyloarthritis (axSpA) is a chronic inflammatory rheumatic disease that affects the axial skeleton (sacroiliac joints and spine) and may lead to peripheral enthesitis, as well as joint and extra-spinal manifestations [1]. It may be associated with comorbidities, in particular cardiovascular diseases (CVD) [2 3]. Physical inactivity might contribute to this risk.

Drug treatment and multimodal exercise are cornerstones for the optimal management of axSpA [1]. Flexibility exercises are effective in improving spinal flexibility, physical function and well-being of people with axSpA, specifically for ankylosing spondylitis (AS), its most relevant subtype [4]. However, the current public health recommendations for physical activity (PA) state that *a program of regular exercise that includes cardiorespiratory, resistance, flexibility and neuromotor exercise training, at well-defined frequency, intensity and duration/repetitions levels, beyond activities of daily living, to improve and maintain physical fitness and health is essential for most healthy adults, and may also apply for adults with certain chronic diseases' [5]*. Large observation studies provide strong evidence that the intensity, but not the amount, of cardio-respiratory exercise is of significance for an effective reduction of the CVD risk in healthy people [6 7]. Given the increased CVD risk in patients with axSpA and the potential protective effect of cardiorespiratory fitness [8] and its safety [9], the inclusion of vigorous cardiorespiratory training (vCRT) in exercise programmes for patients with axSpA is highly relevant. vCRT corresponds to 65-90% HR_{max} or intensity of ≥ about 6MET physical activity for ≥20 minutes performed ≥3 days/week [5]. Recent studies with AS patients showed that vCRT, in appropriate frequency and duration was effective concerning

cardiovascular fitness, as well as safe and feasible [10] and may have impact on disease activity and CVD risk [11].

Therefore, the Swiss patient organisation for people with axSpA (SVMB) aims to implement vCRT in their approximately 80 exercise groups with over 600 participants throughout Switzerland. So far, focus in these groups is on flexibility and resistance exercises.

A small survey revealed that currently only few PTs include elements of CRT, but not in the adequate duration or intensity, and there was no attempt to suggest additional CRT as home exercise (unpublished data).

A focus shift towards vCRT not only requires implementing an additional exercise element, but also a format that supports the initiation and maintenance of individual vCRT. Thus, new knowledge, skills, behaviours and habits need to be adopted by group participants and PTs. Specifically PTs need knowledge and skills for designing and providing effective vCRT, and effective behavioural techniques to support individual participant's long-term adherence.

A successful implementation process requires a planned and systematic approach with clear strategies [12], starting with the exploration of current clinical performance and setting, as well of the barriers and facilitators for change among the stakeholders. Based on these explorations, appropriate implementation strategies can be developed. According to Grol&Wensing [12], barriers and facilitators can be categorized into different levels: a) innovation (in our case vCRT, including feasibility,

attractiveness), b) individual professional (e.g. knowledge, motivation, behavioural routines), c) individual patient (e.g. skills, attitude, compliance), d) social context (e.g. opinion of colleagues, culture of the network, leadership), e) organisational context (staff, capacities, resources, structures) and f) external environment (political and economic factors including (financial) regulations. In summary, facilitators may be 'selling points', whilst barriers anticipate challenges and require tailored strategies as key for successful implementation. Another issue for a successful implementation is to achieve 'coherence' of the desired practice change with the involved health care providers [13]. This may include increasing awareness, familiarity and agreement with the innovation [14].

The aim of study was to explore the barriers and facilitators for performing and providing vCRT among patients with axSpA and physiotherapists (PTs) respectively. Rheumatologists were inquired about their current reasons for referring or not referring patients with axSpA to exercise groups, and their attitude towards vCRT.

Methods:

Study design

A cross-sectional comparative study was performed by online surveys (using SurveyMonkey®) tailored to the three stakeholder groups.

Development of the survey questionnaires

The patient questionnaire: was developed based on three focus groups with different patients with axSpA: 1) active (=PA of ≥150 minutes per week) with participation in exercise group (n=5); 2) active, without participation in exercise group (n=6); 3)

inactive (=PA<150 minutes per week), without participation in exercise group (n=4). The semi-structured interview guide used in these focus groups to explore perceived barriers and facilitators of *performing* vCRT was developed based on a literature review and expert opinion. The content analysis of the focus groups applied a directed approach [15], i.e. the analysis took the numerous amount of literature related to PA barriers and facilitators into account to guide and predefine our barrier and facilitator categories and items. This process provided nine 'categories' of barriers and facilitators. For each of these categories, 'mirroring' items were formulated, i.e. items representing any given aspect as barriers (n=50) and reciprocally also as facilitators (n=54), with regard to vCRT. The assumption was that items, e.g. related to 'motivation' or 'disease symptoms' may reflect barriers or facilitators for vCRT, depending on its phrasing, and moreover, that an item not being a barrier may not necessarily be a facilitator and vice-versa. The final questionnaire contained the following categories (n barrier/n facilitator items) on different framework levels: on innovation level *expectations (8/10);* on individual professional level: *support from health professionals (3/3),* on individual patient level *motivation (4/7), timing in daily routine (9/9), disease symptoms (7/7), knowledge (3/3), and coping (6/7);* on social level *support from family/friends (3/3);* on 'organisational context' level *organisational conditions (7/7).* There were no facilitator and barrier category and items on level 'external environment' identified from the data of the focus groups (see table 2). Survey patients were asked a) to 'choose the three categories, where they experienced the most important barriers and facilitators respectively (= top-3 barrier and top-3 facilitator categories) from a list and b) to rate the barrier and facilitator items within each category on a 4-point scale (not/rather not/rather/very hindering and facilitating' respectively). Furthermore, patients'

demographics (i.e. age, sex, occupation, living situation, participation in exercise group), disease activity using the BASDAI (The Bath AS Disease Activity Index) and self-reported frequency and duration of moderate PA and vCRT per week, using the short International Physical Activity Questionnaire (IPAQ short) were assessed. A preliminary version of the questionnaire was tested for face validity and feasibility by representatives of the patient organisation.

The PT questionnaire was developed based on in-depth telephone interviews with four PTs, who supervised one of the axSpA exercise groups. The semi-structured interview guide used in these interviews to explore barriers and facilitators of *providing* vCRT was developed based on a literature review and expert opinion. Content analysis of the interviews, again using a directed approach [15], provided seven 'categories' of barriers and facilitators. Again, for each category mirroring barrier (n=26) and facilitator items (n=28) were formulated (see 'patients' questionnaire'). The final questionnaire contained the following categories (n barrier/n facilitator items) on different framework levels: on innovation level feasibility *(3/3), expectations (2/3), organisation of vCRT (2/1), instruction of vCRT to be performed by patients independently (8/7);* on individual professional level *knowledge (3/3);* on individual patient level *perceived motivation (3/3);* on organisational level *group composition (3/3), support for providing vCRT (2/5).* There were no facilitator and barrier categories and items on framework levels 'social context' and 'external environment' identified from data of the interviews (see table 3). Survey PTs were also asked a) to choose the top-3 barrier and facilitator categories from a list and b) to rate the barrier and facilitator items on a 4-point scale

(see above). Furthermore PTs' demographics (i.e. sex, age, experience (professional and as group leader) and PA-level (using IPAQ short) were assessed.

The rheumatologist questionnaire was adapted from the PT questionnaire and kept short to enhance the rheumatologists' participation rate. A preliminary version was tested for face validity and feasibility by six rheumatologists. The questionnaire focused on *the rheumatologists' barriers and facilitators for currently (not) referring to PA and exercise groups,* as we assumed that their barriers and facilitators were 'generic' and not limited to the question of 'flexibility or vCRT exercise'. The final version covered seven mirroring (see 'patients' questionnaire') barrier and seven facilitator items respectively on two framework levels: on individual professional level *time during consultation, effectiveness of flexibility exercises, information about exercise groups, reputation of axSpA exercise groups, social support;* on individual patient level *anticipated or perceived (dis)interest of patient, current PA-status of patient.* There were no facilitator and barrier items on framework levels 'innovation', 'social context' and 'external environment' in the survey (see table 4). Rheumatologists were asked to answer the barrier and facilitator items on a 4-point scale (not/rather not/ /rather/very hindering and facilitating' respectively, adding *don't know*). Those indicating to refer 'never' or 'always' their patients to exercise groups, answered only the barrier and facilitator questions respectively; those indicating to refer 'often' or 'sometimes' patients, were asked to answer the barrier and facilitator questions. A final question inquired if the implementation of vCRT would change their number of referrals to the exercise groups. Furthermore, rheumatologists' demographics (i.e. sex, age, professional experience, estimated referrals to exercise) were assessed.

Participants and data collection

The invitation for the online surveys were sent by the SVMB to all German-speaking SVMB members (n=1710) and all PTs (n=84) supervising their exercise groups, and by the Swiss Society for Rheumatology (SSR) to all German speaking rheumatologists (n=428). Reminders were sent to all addressees after three weeks.

Ethical approval

The survey invitations were sent by the SVMB and the SSR and the registration of ID and IP addresses on the host server was inactive to preserve anonymity of the survey participants. Therefore no ethical approval was required by Swiss law.

Analysis

Characteristics (patients, PTs, rheumatologists) are presented as frequencies (percentages), or means with standards deviations (SD) where appropriate. The frequency of the top-3 barrier and facilitator categories is reported as absolute number and percentage. To quantify the presence of barriers and facilitators for performing vCRT (patients' perspective), providing vCRT (PTs perspective) and referring to exercise (rheumatologists' perspective), the ratings were dichotomised, i.e. as barrier item (very hindering/rather hindering) or no barrier item (not hindering/rather not hindering), as facilitator item (very facilitating/rather facilitating) or no facilitator item (not facilitating/rather not facilitating). The weekly minutes of vigorous PA were doubled and added to the weekly minutes of moderate PA, resulting in the dichotomous < or ≥150 minutes/week for inactive and active people respectively [16]. We assumed that active and inactive patients may have different barriers and facilitators for performing vCRT and analysis compared ratings between

active and inactive patients by Chi square test. The data were analysed using SPPS, version 23 (SPSS, Chicago, IL).

Results

In total, 704 patients with axSpA (41.2%), 47 PTs (56%) and 75 rheumatologists (17.5%) participated. Participants who did not complete the survey were kept, if they had at least answered the barrier questions. This resulted in the final number of 575 patients with axSpA (34%), with n=535-575 available for analysis due to missing data; 40 PTs (48%), with n=37-40 available for analysis) and 73 rheumatologists, referring to exercise group 'always' (n=19); 'often' (n=37); 'sometimes' (n=12); 'never' (n=5). The answering patients, PTs and rheumatologists were all representative for their peer sample by age and sex. Their demographics are presented in Table 1.

Patients' view on barriers/facilitators:

Table 2 shows how many patients rated the barrier and facilitator categories and items in the survey on each level of the framework. The top-3 barrier categories included *low motivation* (n=317=/59%), *unsuccessful timing in daily life* (n=292/55%) and *hindering disease symptoms* (n=272/51%). The top-3 facilitator categories included *high motivation* (n=248/47%), *good organisational conditions* (n=217/41%), *facilitating disease symptoms* (n=209/40%). The top-3 barrier and facilitator categories, all on the individual level, were chosen the most by inactive and active patients, however, significantly more inactive than active patients choose *low motivation* as category (p=0.01), as well as most items within this category i.e. *low energy, low discipline* and *low motivation* (all p≤0.03). The category *disease*

symptoms was more a facilitator (p=0.04) for active compared to inactive patients, however, the barrier and facilitator items related to *disease symptoms* were equally important for both subgroups. The barrier category *unsuccessful timing in daily routine* was important for both subgroups (p=0.06), however the barrier items *difficult time planning* (p<0.00), *high time expenditure* (p<0.00) and give up other habits (p=0.01) were more often selected by inactive than active patients. Further, some items from different barrier categories were chosen more frequently as barriers by inactive than active patients, i.e. *not know which sport is good* (p=0.03), *vCRT is not fun* (p=0.05) and *vCRT may worsen AS in the short-term* (p=0.03), *little support from family/friends* (p=0.01), whilst active patients selected more frequently the facilitators *performing CRT in a group* (p<0.00) and *support by the supervising PT* (p=0.01) compared to inactive patients.

PTs' view: Table 3 shows how many PTs rated the barrier and facilitator categories and items in the survey on each level of the framework. *Heterogeneous groups* (n=26/70%), *difficult organisational conditions* and *low perceived motivation* (both n=19/51%) were chosen as the most important barrier categories by the PTs. The three top-ranked facilitator categories were *knowledge* (n=20/54%), *homogeneous group composition* and *high own/assumed (in patients) motivation* (both n=17/46%). On the level 'innovation', the facilitator items were supported by at least 73% of the PTs, whereas the barrier items were rated to a lower extent (maximal 43%), except the items *uncertainty if participants will perform vCRT on their own* (73%) and *little time to find individually suitable sport for each participant* (55 %).

Rheumatologists' view: Table 4 shows how many rheumatologists rated the barrier and facilitator categories and items in the survey on each level of the framework. A majority supported the barrier items *not enough information (47%)* and *anticipated or perceived disinterest of patient* (50%), whereas almost all rated *exercise is considered important even in limited consultation time* (96%) and *clear evidence for effectiveness of flexibility exercises* (91%) as facilitators. Rheumatologists who referred 'often' or 'sometimes', in general rated these facilitators less or stated 'I don't know' more often than those 'always referring'. A total of 32 rheumatologists (47%), independently from their actual referral activity, indicated they were going to refer more patients to the exercise groups if vCRT was included.

Discussion

To our knowledge, this is the first study analysing the barriers and facilitators for vCRT among patients with axSpA, PTs and rheumatologists. For patients and PTs, 'motivation' was most important as barrier and facilitator alike, whilst rheumatologists rated the 'perceived disinterest of patients' as strongest barrier and 'the importance and evidence base of exercise' as most important facilitators. The fact that each stakeholder group had its specific perceptions and especially the diverging extent of perceived barriers and facilitators among active and inactive patients, points out the need to develop different implementation strategies for each (sub)group.

Our assumption that same categories and items may act as barriers and facilitators for vCRT was confirmed. This was similarly and illustrated in a model on barriers and facilitators for exercising in OA patients [17].

Patients' perceptions: Patients overall selected the categories 'motivation', 'disease-related symptoms', and 'timing in daily routine', all on the individual patient level, as the top-3 barriers and facilitators. However, significantly more inactive than active patients chose the category 'low motivation' as barrier, whilst significantly more active patients chose the category 'facilitating disease symptoms' as facilitator. It was even a general pattern that barrier items were chosen as barriers by significantly more inactive people but facilitator items as facilitators by significantly more active people. Previous research is controversial on this point. Whilst Iversen et al found that highly active patients viewed PA differently than low active patients [23], a review based on 26 articles, concluded that the main barriers were not different between those who exercised regularly and those who did not [19].

The barrier categories on the 'individual patient level', i.e. 'no motivation' and 'difficult organisation in daily routine' are barriers that patients share with healthy people [19]. In our study the inactive participants perceived many more items within these categories as barriers than the active ones, namely 'low energy', low discipline', 'low motivation' as well as 'vCRT may worsen AS in the short-term', 'high time expenditure for vCRT' and 'fear to give up other habits for vCRT'. Thus, inactive patients have a special need for tailored interventions and problem solving strategies. The presence of barriers combined with the way the patient negotiates and effectively counters the barriers influences physical activity and exercise behaviour [18]. Active patients may have experienced the benefits of PA and finally integrated it as a habit in their daily routine. Thus the common advice of scheduling the exercise time as any other appointment to overcome the difficult organisation in daily routine [19] may work differently in active and inactive patients.

Interestingly, in our study there were no differences between the specific disease symptom items as facilitators and barriers in active vs inactive patients. We assume that various disease symptoms may be strong barriers to PA, but also act as cue to action (e.g. pain or stiffness), irrespective of the activity level of the patients. However, a recent study found that a significantly larger proportion of AS patients (78%) than healthy controls (59%) experienced barriers to being physically active and that among these patients disease-related barriers were more common than regular barriers [20], and fatigue was identified as a serious barrier for being physically active in AS patients [20-22].

Many categories identified in the focus group with the patients with axSpA related to vCRT were similar to the themes identified by interviews with RA patients and rheumatologists with regard to PA. Mutually identical barriers were vCRT/PA as daily routine; disease symptoms, social support, organisational condition/intimidation [23]. Thus, for implementing vCRT and PA promotion in general, it is important to understand the patients' perceptions and conceptualisation of vCRT/PA, i.e. to identify the motivational and organisational barriers and facilitators on the individual patient level. Furthermore, the identified barriers need to be targeted differently for active and for inactive people, as maintaining and starting PA and vigorous exercise have different challenges.

PTs' perceptions: The most important barrier category was *heterogeneous group composition,* with regard to age, health and fitness status. This barrier may become less relevant with the new approach of instructing and performing vCRT individually. However for successful implementation, it will be important to address all the barriers

linked to ‘organisational conditions’, ‘low motivation’, and the specific barriers to the innovation itself, i.e. ‘to instructing vCRT to be performed by patients independently’, such as little time, no incentives, and not enough knowledge. The frequently chosen barrier items from the category ‘low motivation’, i.e. ‘fear that participants are not interested’ or ‘… find vCRT too strenuous’ and ‘uncertainty if participants will perform vCRT on their own’, show that the PTs anticipate motivation problems of their group participants. PTs will therefore need more specific knowledge and skills in behaviour and behaviour change techniques, to act as coaches and counsellors to facilitate exercise behaviour (change) of their participants. The PTs will also need support from the patient organisation, in form of reimbursed extra time for the individual coaching of their participants. This individual coaching must be based on the current fitness status of the patient and include shared decisions on goals and action plans, to not only support the initiation (or maintenance) of vCRT, but also the motivation of the participants - and the PTs alike. *Rheumatologists’ perceptions*: The importance and the clear evidence of (flexibility) exercise were strong facilitators for a large majority of rheumatologists to refer patients to the exercise groups. Therefore, the evidence for the effectiveness and safety of vCRT may also be an additional facilitator and in fact, our study showed that a majority of rheumatologists would refer more patients than today to the exercise groups if vCRT was included. However, it is of concern that these experts felt they had not enough information about the exercise groups, a central offer for patients with axSpA from the patient organisation. The regularly referring rheumatologists indicated the good reputation of the exercise groups, whereas the less referring rheumatologists rather perceived the exercise groups as ‘old-fashioned’. The barriers on the individual patient level (‘disinterest’ and ‘already active’) seem to discourage the rheumatologists, within their time and

task constraints, from motivating their patients to join an exercise group. In fact, many patients with axSpA are already physically active; however research showed that a substantial proportion of patients did not reach the public health recommendations for PA [24], especially with regard to the intensity of CRT [25]. There is also evidence that the rheumatologists' perceived importance of PA strongly influences the patients' motivation and intention to exercise [26 27].

With regard to the future implementation process, most barrier and facilitator items for patients, PTs and rheumatologists were linked to the levels of the individual patient, individual professional, but also to the innovation itself, and social and organisational context. The specific items determine which implementation strategy to use, and the level indicates the target group of the strategy.

Limitations and strengths: The results are based on one of the largest survey among patients with axSpA, also including PTs and rheumatologists. Given the high response rate among patients, independent from their participation or interest in exercise groups, their answers may be generalizable. In contrast to the high response rate among PTs, the response rate of the rheumatologists was substantially lower, although the respondents were representative for the whole group. Interestingly, not only rheumatologists referring their patients with axSpA more or less consequently to the exercise groups, but also some who indicated to never refer patients participated in the survey, so that the answers cover a broad range of perceptions.

The questionnaires were developed based on the results of focus groups, telephone interviews and feasibility testing. The subsequent stakeholder-specific surveys allowed an exploration of the specific barriers and facilitators. Interestingly, items were substantially more rated as facilitators than as barriers in all surveys.

One limitation of this study, inherent in the design, is the fact that the questionnaires were not validated before its use. However in implementation research, evaluating the specific barriers is an important step that guides the development of tailored implementation strategies [28] and basic principles were derived from the 'barrier and facilitator assessment instrument [29]. Another limitation may be the mirroring questions that may have complicated the questionnaires and increased the burden for the responders; however, our strategy for 'mirroring' barrier and facilitator questions was confirmed by the results and enriched the gained information.

Conclusions

Each stakeholder-group perceived specific barriers and facilitators for vCRT. For patients and PTs these were mainly related to motivation, whereas rheumatologists focused more on the evidence-base. Moreover, there was a diverging extent of perceived barriers and facilitators among active and inactive patients. All these findings emphasize the need to develop target-group specific, and, for patients, individualised implementation strategies.

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Table 1: Participants' characteristics

	All Patients (n=575)	Active Patients n=350 (61%)	Inactive Patients n=220 (39%)	Physiotherapists (n=40)	Rheumatologists (n=73)
Total / response rate (%)	1710 (42)			84 (56)	428 (17)
Women, n (rate %)	250 (43)	150 (43)	91 (41)	31 (78)	22 (30)
Age, years, mean (SD)	51.9 (±12.5)	52.4 (±12.8)	51.0 (±12.0)	43.05 (±11.4)	52.22 (±8.8)
Occupation, n (%)				NA	NA
Professional	413 (72)	238 (68)	175 (80)		
Volunteer	63 (11)	40 (11)	23 (11)		
Student	22 (4)	11 (3)	11 (5)		
Housewife/-man with kids	87 (15)	59 (17)	28 (13)		
Housewife/-man, without kids	102 (18)	63 (18)	39 (18)		
Retired	118 (21)	83 (24)	35 (16)		
Unemployed / illness pension	38 (7)	24 (7)	14 (6)		
Living situation, n (%)				NA	NA
Alone	79 (14)	40 (11)	39 (18)		
Spouse	278 (48)	172 (49)	106 (48)		
Family with kids	199 (35)	128 (37)	71 (32)		
With others	11 (2)	8 (2)	3 (1)		
Participation in exercise group, n (%)				NA	NA
Yes, regular	187 (33)	121 (35)	66 (30)		
Yes, sometimes	23 (4)	17 (5)	6 (3)		
No, but interested under conditions	202 (35)	114 (33)	88 (40)		
No, not interested	154 (27)	96 (27)	58 (26)		
BASDAI (0-10)	3.19 (±2.2)	3.30 (±2.3)	3.02 (±2.1)	NA	NA
PA (IPAQ short)					NA
Active, n (%)	350 (61)			22 (55)	
weekly minutes, mean (SD)		295.6 (±158.4)		252.3 (±166.5)	
Inactive,	220 (39)			18 (45)	
weekly minutes, mean (SD)			86.4 (±40.3)	86.7 (±37.4)	
Graduated as PT /Rheumatologist years, mean (SD)	NA	NA	NA	19.4 (±12.2)	15.5 (±8.6)
Experience as exercise group leader	NA	NA	NA	10.1 (±8.4)	NA
Working as exercise group leader	NA	NA	NA		NA
1x/week				21 (55)	
2-3x / month				9 (23)	
Estimated number of patients with axSpA per	NA	NA	NA	NA	5 (0-100)

month (median, IQR)					
Referring to exercise group, n (%) Always Often Seldom Never	NA	NA	NA	NA	 19 (26) 37 (51) 12 (16) 5 (7)

SD = Standard Deviation; IQR = Interquartile Range; NA = Not applicable; BASDAI = Bath AS Disease Activity Index; PA = Physical Activity; IPAQ short = International Physical Activity Questionnaire (short form); Active: ≥ 150 min/week; Inactive: < 150 min/week).

Table 2: All categories and items of barriers and facilitators rated by patients

FRAMEWORK LEVEL *Barrier category (rank as chosen as top-3)* Barrier items	Item rated as rather hindering/hindering by n (%)				**FRAMEWORK LEVEL** *Facilitator category (rank as chosen as top-3)* Facilitator items	Item rated as rather facilitating/facilitating by n (%)			
	All	Active	Inactive	*p-value		All	Active	Inactive	*p-value
INNOVATION									
Negative expectation (rank 8)	*65 (12.3)*	*44 (12.6)*	*21 (9.5)*	*0.27*	*Positive expectation (rank 5)*	*182 (34.7)*	*114 (32.6)*	*68 (30.1)*	*0.68*
CRT is not fun	178 (30.9)	98 (28)	78 (35.4)	**0.05**	Experience progress	504 (87.6)	311 (88.8)	190 (86.4)	0.95
CRT is boring	151 (26.2)	89 (25.5)	60 (27.2)	0.23	CRT improves fitness	496 (86.2)	310 (88.6)	183 (83.2)	0.31
AS worsens in short-term	142 (24.7)	72 (20.5)	68 (30.9)	**0.03**	CRT improves AS in long-term	482 (83.8)	301 (86)	178 (80.9)	0.44
AS worsens in long-term	123 (21.4)	65 (18.6)	56 (25.4)	0.09	Performing CRT is fun	490 (85.2)	304 (86.9)	185 (83.2)	0.76
Insecurity if benefit > effort	123 (21.4)	65 (18.6)	55 (25)	0.25	CRT strengthens for coping	470 (81.7)	296 (84.6)	171 (77.7)	0.20
Unclear recommendations	119 (20.7)	70 (20.0)	47 (21.3)	0.52	CRT improve AS in short-term	456 (79.4)	284 (81.4)	169 (76.8)	0.71
Fear to exhaust/overburden	101 (17.6)	58 (16.6)	40 (18.2)	0.92	Clear recommendations	451 (78.5)	280 (80)	168 (76.3)	0.10
Fear to injure oneself	76 (13.2)	48 (14.7)	26 (11.8)	0.75	body perception improves	492 (85.6)	309 (88.3)	180 (81.8)	0.16
					CRT supports weight control	441 (76.7)	276 (78.9)	162 (73.6)	0.77
					CVT is fun	469 (81.5)	293 (83.7)	173 (78.7)	0.81
INDIVIDUAL PROFESSIONAL									
Little support, HPs (rank 9)	*49 (9.3)*	*33 (9.4)*	*16 (7.3)*	*0.37*	*Much support, HPs (rank 9)*	*79 (14.9)*	*33 (9.4)*	*16 (7.3)*	*0.37*
Little support by MD	109 (18.9)	69 (19.7)	37 (16.8)	0.66	Support by PT	417 (75.3)	266 (76)	164 (74.5)	0.85
Little support by PT	95 (16.5)	60 (17.1)	33 (15.0)	0.89	Support by MD	433 (72.5)	257 (73.4)	157 (71.4)	0.82
Little support by SVMB PT	55 (9.6)	36 (10.3)	18 (8.2)	0.84	Support by SVMB PT	408 (71)	254 (72.6)	151 (68.6)	**0.01**
INDIVIDUAL PATIENT									
Low motivation (rank 1)	*317 (59.4)*	*180 (51.4)*	*137 (62.3)*	**0.01**	*High motivation (rank 1)*	*248 (47.1)*	*145 (41.4)*	*103 (46.8)*	*0.21*
Low energy	274 (48)	160 (45.7)	114 (51.8)	**0.03**	High motivation	483 (84.0)	297 (84.9)	182 (82.7)	0.24
Low discipline	273 (47.4)	152 (43.5)	119 (54.1)	**0.00**	High energy	477 (83.0)	291 (83.2)	182 (82.8)	0.64
Low motivation	258 (45.2)	143 (40.8)	115 (52.3)	**0.01**	High discipline	466 (81.0)	285 (81.4)	177 (80.5)	0.25
Difficult restart after long-term break e.g. lack of time, disease, illness	228 (39.7)	131 (37.5)	93 (42.3)	0.24	Commitment twd. oneself	443 (77.0)	278 (79.4)	161 (73.2)	0.35
					Regularity, no interruptions	438 (76.2)	273 (78)	161 (73.2)	0.08
					Financial investments	363 (63.1)	230 (65.7)	131 (59.6)	0.11
					Compare/compete with others	249 (43.1)	166 (47.4)	82 (37.3)	**0.00**

Unsuccessful timing in daily routine (rank 2)	*292 (55)*	*171 (48.0)*	*121 (55.0)*	*0.16*	*Successful timing in daily routine (rank 4)*	*186 (35.2)*	*104 (29.7)*	*82 (37.3)*	*0.06*
Difficult time planning	259 (45)	142 (40.6)	115 (52.3)	**0.00**	CRT has become a habit	479 (83.3)	296 (84.6)	179 (81.3)	0.89
High time expenditure	255 (44.3)	142 (40.6)	110 (50.0)	**0.00**	Time expenditure is feasible	475 (82.6)	298 (85.1)	173 (78.6)	0.28
No possibility at work	225 (39.2)	129 (36.8)	93 (43.3)	0.23	CRT supports stress coping	468 (81.4)	288 (82.2)	176 (80)	0.82
Not possible on way to work	195 (33.9)	117 (33.4)	77 (35.0)	0.13	Have weather alternatives	463 (80.6)	286 (81.7)	174 (79.1)	0.42
Dependence on weather	179 (31.1)	99 (28.3)	78 (35.4)	0.22	CRT distracts from disease	450 (78.2)	276 (78.9)	170 (77.3)	0.55
To give up other habits	138 (24)	74 (21.2)	61 (27.7)	**0.01**	Efficient time planning	444 (77.2)	269 76.8)	171 (77.7)	0.72
Fear have to interrupt when health problems	136 (23.6)	77 (22.0)	58 (26.3)	0.32	CRT anywhere/anytime Possibility on way to work	405 (70.4) 338 (58.8)	250 (71.4) 209 (59.7)	152 (69) 124 (56.3)	0.53 0.49
No occasions for CRT when traveling/holidays	134 (23.3)	76 (21.8)	57 (25.9)	0.21	Combine CRT with other things (eg listen to music)	329 (57.2)	200 (57.1)	126 (57.3)	0.81
Fear not to recover sufficiently after CRT	94 (16.4)	51 (14.6)	41 (18.7)	0.60	Possibility for CRT at work	317 (55.2)	191 (54.5)	124 (56.3)	0.61
Hindering disease symptoms (rank 3)	*272 (51.4)*	*178 (50.9)*	*94 (42.7)*	*0.06*	*Facilitating disease symptoms (rank 3)*	*209 (39.5)*	140 (40.0)	69 (31.4)	0.04
Fatigue	339 (58.9)	203 (58.0)	132 (60.0)	0.60	Stiffness	364 (64.1)	231 (66)	130 (59.1)	0.24
Pain	330 (57.9)	194 (55.4)	133 (60.4)	0.27	Pain	340 (59.1)	219 (62.6)	120 (54.6)	0.09
Stiffness	297 (51.7)	178 (50.8)	117 (53.1)	0.80	Depressed mood	297 (51.7)	194 (55.5)	102 (46.3)	0.28
Weakness	257 (44.7)	155 (44.3)	99 (45.0)	0.33	Sleep problems	296 (51.4)	192 (54.8)	104 (47.3)	0.15
Other diseases	215 (37.3)	129 (38)	78 (35.4)	0.65	Weakness	286 (49.8)	184 (52.6)	102 (46.4)	0.20
Depressed mood	211 (36.7)	124 (35.4)	84 (38.1)	0.61	Fatigue	269 (46.6)	174 (49.7)	95 (43.2)	0.75
Sleep disorders	210 (36.6)	133 (36.9)	79 (35.9)	0.88	Other diseases	207 (36.0)	138 (39.4)	69 (31.3)	0.07
Little knowledge on (rank 4)	*208 (39.3)*	*134 (33.8)*	*74 (33.4)*	*0.21*	*Good knowledge on (rank 6)*	*180 (34.1)*	*117 (33.4)*	*63 (28.6)*	*0.23*
which sport is good for CRT	153 (26.6)	80 (22.8)	71 (32.3)	**0.03**	benefit of CRT	478 (83.1)	295 (84.3)	180 (81.9)	0.42
how to perform CRT	141 (24.5)	75 (21.4)	65 (29.5)	0.21	how to perform CRT	466 (81.1)	285 (81.4)	177 (80.4)	0.21
benefit of CRT	130 (22.6)	73 20.5)	57 (25.9)	0.42	various sport activities for CRT	357 (79.5)	284 (81.1)	170 (77.2)	**0.03**
Unsuccessful coping (rank 6)	*86 (16.6)*	*56 (16.0)*	*30 (13.6)*	*0.44*	*Successful coping (rank 7)*	*148 (28.2)*	*98 (28.0)*	*50 (22.7)*	*0.16*
Not have enough energy in bad phase	339 (59.2) 158 (27.5)	198 (56.6) 93 (26.5)	139 (63.1) 62 (28.1)	0.08 0.91	Be able to accept disease Clearness about what helps	465 (80.9) 493 (85.7)	287 (82) 303 (86.6)	175 (79.5) 187 (85)	0.14 0.07
Have to take drugs	135 (25.2)	92 (26.3)	52 (23.7)	0.67	Expect something from	490 (85.2)	305 (87.2)	182 (82.7)	0.13
Have to / want to rest	131 (22.7)	80 (22.9)	49 (20.3)	0.56	oneself despite the AS				
Quarrel with disease	125 (21.7)	68 (19.5)	56 (24.4)	0.39	Build reserves in good phases	463 (80.6)	291 (83.1)	170 (77.3)	0.14
Not have to/want to perform	113 (19.6)	67 (19.2)	45 (20.5	0.19	Overcome bad phase by CRT	438 (76.1)	276 (78.9)	160 (72.8)	0.54

CRT in good phases Insecure what to expect from oneself					Take drugs to be able to move Distract from disease by CRT	364 (63.3) 435 (75.7)	233 (66.6) 276 (78.9)	130 59.1) 157 (71.4)	0.48 0.07
SOCIAL CONTEXT									
Little support, family/friends (rank 7)	*67 (12.5)*	*39 (11.1)*	*28 (12.7)*	*0.16*	*Much support, family/friends (rank 8)*	*127 (23.9)*	*84 (24.0)*	*43 (19.5)*	*0.21*
perform CRT on one's own perform CRT in a group Little support by family/friends	162 (28.2) 113 (19.7) 104 (18.1)	95 (27.2) 64 (18.3) 48 (13.7)	67 (30.4) 48 (19.9) 54 (24.6)	0.57 0.27 **0.01**	Much support by family/friends Perform CRT on one's own Perform CRT in a group	472 (82.3) 398 (69.2) 376 (65.4)	296 (84.6) 250 (71.5) 236 (67.4)	172 (78.2) 144 (65.4) 137 (62.3)	0.48 0.14 **0.00**
ORGANISATIONAL CONTEXT									
Difficult organisational conditions (rank 5)	*156 (29.3)*	100 (26)	56 (25.5)	0.42	*Good organisational conditions (rank 2)*	*217 (41.3)*	*130 (37.1)*	*87 (39.5)*	*0.57*
instructor may not be familiar with AS	203 (35.3)	116 (33.1)	84 (38.2)	0.48	Nature (forests, walks) nearby Good sport facilities nearby	498 (86.6) 468 (77.9)	307 (87.7) 279 (79.7)	187 (85) 165 (75)	0.14 0.44
Few suitable sport groups	153 (26.6)	85 (24.3)	66 (30.0)	0.30	Instructor familiar with AS	441 (76.7)	272 (77.6)	165 (75)	0.45
Costs for desired activity	149 (25.9)	84 (24.0)	63 (28.6)	0.08	Suitable, sport groups nearby	375 (65.2)	237 (61.4)	135 (61.4)	0.42
No sport facilities nearby	137 (23.8)	89 (25.4)	46 (20.9)	0.11	Counselling about devices	342 (59.5)	222 (63.4)	116 (52.7)	0.09
Have to buy sport devices	120 (20.8)	71 (20.3)	47 (21.4)	0.19	Financial support for devices	307 (53.4)	199 (56.8)	107 (48.7)	0.25
Being observed during CRT	100 (17.4)	55 (15.7)	43 (19.5)	0.62	Perform CRT unobserved	297 (51.7)	190 (53.3)	105 (47.7)	0.15
Nature too far away	70 (12.1)	44 (12.5)	25 (11.4)	0.23					
EXTERNAL ENVIRONMENT (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)									

*p-value from chi square test, comparing the frequency of ratings from active vs inactive patients

NA = Not Applicable

Table 3: All categories and items of barriers and facilitators rated by physiotherapists

FRAMEWORK LEVEL Barrier category (ranked as chosen as top-3) Barrier items	Item rated as rather hindering/ hindering by n (%)	**FRAMEWORK LEVEL** *Facilitator category* (ranked as chosen as top-3) Facilitator items	Item rated as rather facilitating / facilitating by n (%)
INNOVATION			
Negative expectations (rank 5)	11 (29.7)	*Positive expectations (rank* 4)	16 (43.2)
Fear that harm of vCRT exceeds benefit Uncertainty if benefit of vCRT exceeds effort	6 (15) 4 (10)	Expectations that participants feel better by vCRT Expectations that benefit exceeds effort Expectations that participants can cope with vCRT	35 (87.5) 33 (82.5) 32 (80)
Low feasibility of vCRT within exercise group (rank 4)	(45.9)	*High feasibility of vCRT within exercise group (rank 7)*	10 (27.0)
Little time besides usual exercise programme Weather conditions for outdoor vCRT	17 (42.5) 17 (42.5)	Enough time to provide vCRT besides other exercise elements within exercise groups	29 (72.5)
Specific barriers to instructing vCRT to be performed by patients independently	*NA**	*Specific facilitators for instructing vCRT to be performed by patients independently*	*NA**
Uncertainty if participants will perform vCRT on their own Little time to find individually suitable sport for each participant Participants' health and fitness status not optimal for vCVT Little time for instruction of vCRT within exercise group No incentives for new design of exercise lessons Uncertainty if benefit of vCRT instruction > effort Little knowledge about how to instruct the participants to perform vCRT independently Fear that instruction to individual vCRT is more harmful than beneficial (e.g. injuries)	29 (72.5) 22 (55) 17 (42.5) 15 (37.5) 11 (27.5) 11 (27.5) 9 (22.5) 2 (5)	Knowledge about how to instruct participants to perform vCRT independently Expectations that benefit > effort Incentives for new design of the exercise lessons Participants' health and fitness status is appropriate for vCVT Expectation that participants will find motivation and energy to perform vCRT on their own Enough time to find a suitable sport together with every participant Expectations that benefit exceeds risks (e.g. risk of injury, sporadic disorders)	36 (90) 34 (85) 33 (82.5) 31 (77.5) 31 (77.5) 30 (75) 29 (72.5)
INDIVIDUAL PROFESSIONAL			
Little Knowledge about (rank 6)	8 (21.6)	*Good knowledge about (rank 1)*	20 (54.1)
structured organisation of vCRT	9 (22.5)	Clear, precise recommendations from studies	37 (92.5)

suitable sports for vCRT Unclear/unprecise recommendations from studies	7 (17.5) 4 (10)	Knowledge about suitable sports for vCRT Knowledge about structured design of vCRT	36 (90) 34 (85)
INDIVIDUAL PATIENT			
Low motivation (rank 2)	19 (51.4)	*High own / assumed (in patients) motivation (rank 2)*	17 (45.9)
Fear that participants are not interested Fear that participants find vCRT too strenuous	18 (45) 17 (42.5)	Expectation that vCRT gets a habit Expectation that participants are interested	30 (75) 30 (75)
SOCIAL CONTEXT (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)			
ORGANISATIONAL CONTEXT			
Heterogeneous group composition (rank 1)	26 (70.3)	*Homogenous group composition (rank 2)*	17 (45.9)
Health and fitness status too diverging among participants Participants' health/fitness status not optimal for vCRT Age of participants too diverging	25 (62.5) 21 (52.5) 20 (50)	Health / fitness status of all participants sufficient for vCRT Health / fitness status of participants similar Age of participants is similar	29 (72.5) 25 (62.5) 25 (62.5)
Little support for providing vCRT within exercise group (rank 7)	5 (13.5)	*Good support for providing vCRT within exercise group (rank* 6)	12 (32.4)
Few Incentives for new design of the exercise lessons Little support by SVMB	10 (25) 2 (5)	Enough incentives for new design of the exercise lessons Participants are motivated for vCRT by HCP/family/friends Specific referral for vCRT by physician Participants know about importance of vCRT Enough support by SVMB	34 (85) 34 (85) 33 (82.5) 32 (80) 32 (80)
Difficult organisational conditions (rank 2)	19 (51.4)	*Good organisational conditions (rank 4)*	16 (43.2)
No training devices (e.g. Polar watch) Unsuitable outdoor possibilities nearby Unsuitable facility for exercise group	24 (60) 13 (32.5) 7 (17.5)	Suitable facility for exercise group Outdoor/ nature easily accessible Training devices available (e.g. pulse watches)	34 (85) 32 (80) 24 (60)
EXTERNAL ENVIRONMENT (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)			
-	NA	-	NA

NA = Not Applicable

Table 4: Barriers and facilitators rated by rheumatologists

Barriers			Facilitators		
FRAMEWORK LEVEL Barrier items	Item rated as rather hindering / hindering (n=54)	Don't know	**FRAMEWORK LEVEL** Facilitator items	Item rated as rather facilitating / facilitating (n=68)	Don't know
INNOVATION (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)					
INDIVIDUAL PROFESSIONAL					
Not enough time during consultation	18 (33%)	5 (9%)	Exercise is important enough even in limited consultation time	65 (96%)	0
Doubts that flexibility exercises are helpful	1 (2%)	1 (2%)	Clear evidence for effectiveness of flexibility exercises	62 (91%)	4 (6%)
Not enough information about exercise groups	25 (47%)	5 (9%)	Enough information about exercise groups	47 (69%)	6 (9%)
Old-fashioned reputation of exercise groups	16 (30%)	12 (22%)	Good reputation of exercise groups	40 (59%)	23 (34%)
Social exchange among AS patients may not be helpful	9 (17%)	8 (15%)	Social exchange among AS patients may be helpful	53 (78%)	8 (12%)
INDIVIDUAL PATIENT					
Anticipated or perceived disinterest of patient towards PA	27 (50%)	5 (9%)	Anticipated or perceived interest of patient towards PA	44 (65%)	11 (16%)
Patient already physically active (>150min / week)	21 (39%)	9 (17%)	Patient not enough physically active (>150min/week)	51 (75%)	10 (15%)
SOCIAL CONTEXT (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)					
ORGANISATIONAL CONTEXT (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)					
ECONOMIC AND SYSTEM CONTEXT (NA, i.e. no facilitator and barrier categories and items in questionnaire on this framework level)					

PA = Physical activity, PT = physiotherapy, NA = Not Applicable

The items related to barriers were not presented/asked to the rheumatologists who were 'always' referring (n=19); the questions related to facilitators were not asked to the rheumatologists who were 'never' referring (n=5) (n total = 73).